

## **IEA Sponsored Workshop on Remote Collaboration in Fusion Research**

The October 9, 1996 Workshop provided the first real opportunity for the a cross section of the world fusion community to exchange information and views about remote collaboration. The Workshop was endorsed as an IEA supported activity by a Working Group on Remote Participation established by the IEA FPCC

The Workshop's presentations indicated that there was substantial interest in applying telecommunications to improving the quality of collaborations. The presentations described current activities ranging from remote collaboration as an integral element in ongoing research, as in the case of LLNL-GA collaboration on DIII-D, to specific active planning and early implementation, as in the case of Trilateral Euroegio Cluster, to situations where the most basic infrastructure such as support for e-mail is lacking.

In the first presentation Dr. Arthur Katz pointed out that the time was ripe for remote collaboration because of the available technology, the challenge and expense of fusion research, and the consequent need for integrating the world's research resources. He also identified several key issues that could be categorize as technical such as network capacity and security, as well as management and social requirements such as cost sharing and the demands for the development of remote working relationships. The most difficult challenge right now is inertia, motivating researchers to divert their limited time from research to learn and establish these systems.

Dr. Robert Aymar, ITER Director observed that ITER with three sites and four national Home Teams currently used international electronic information exchange as an integral part of its activities. For the future he noted it was essential to involve fusion institutions in the participating nations in ITER operations, since it would maximize participation and minimize staff at the ITER central site. This approach would amplify the benefits to the participating ITER parties. Dr. Aymar commented that technology over the next decade would be expected to progress sufficiently so it would not be the issue, instead organizing and managing remote collaborations is likely to be greatest challenge.

Dr. Thomas Casper, LLNL, described the joint work of LLNL, PPPL, GA, ORNL, MIT to test the tools that can be used to perform remote collaboration. These activities included the linking of computers located at several sites for analysis, security, file distribution, and telepresence (techniques for audio/video connections and remote experimental control). The fusion activity described was one of five projects supported by the Department of Energy (DOE) in its Distributed Collaboratory Experimental Environments Initiative. Casper noted this effort will be extended with a new DOE initiative, DOE2000, supporting the collaboratory concept and advanced computation. Based on the fusion project's experience he observed that (1) it was difficult to overcome research and management concerns that this approach would get in the way of the physics, (2) existing data acquisition systems create a

"legacy" problem in some cases, and (3) substantial personal effort as well as improved audio/visual technology are needed to establish a working relationship which is "comfortable and natural" for all Parties.

Dr. Martin Greenwald, MIT described the experience of demonstrating for the first time the remote operation of a tokamak, the Alcator C-Mod experiment at MIT operated from LLNL. He noted that productive physics experiments not just communication tests were accomplished during this demonstration. Physics operations were directed from LLNL, with systems managing plasma current, position, shape, density and heating remotely controlled. He emphasized that power supply current and voltage programming was under remote control - but critical engineering systems such as power supply current and voltage limits and interlocks (along with machine vacuum, heating, cooling) remained under local MIT control. Greenwald commented that network capacity on the order of 10's of Millions of bits per second (Mbps) is required for successful remote operations. Interpersonal communications was identified as key to assuring remote operations worked effectively, leading to the observations that audio/visual tools were critical.

Dr. Stephen Jardin. PPPL provided a somewhat different perspective, noting that as the technical ability to access various sites grows the value of sharing analytical codes would increase. He focused on the benefits of creating a world wide compatible system of codes that could be applied to many different experiments. The integration of these codes creates set of tools that both depend on the telecommunications infrastructure for operational support while the codes themselves are critical to extracting full value from the new communications capability. A Fusion Science Computing Committee in the U.S. to promote standards and compatibility among fusion codes has been formed and he welcomed other scientists from around the world to join this effort.

Drs. A.A.M. Oomens, FOM, and Karl Kreiger, IPP-Garching, discussed European activities. Dr. Oomens described the effort to develop a "Virtual Control Room" (VCR) within the newly formed Trilateral Euroregio Cluster between institutes in Germany, Belgium and the Netherlands. Oomens noted that they remote participation would allow full technical involvement in the TEXTOR 94 experiment in Germany without loss of national program identity. The distances between the institutes were sufficient large to allow them to explore all the problem of remote participation with the advantage of being close enough to allow them to visit the experiment if something went wrong. A pilot project, REMOT, has already been funded as a first step toward building a VCR.

Dr. Kreiger discussed the current experience at Garching which included using the WWW for sharing data and operational information and an initial step in operating diagnostics remotely. More ambitious collaborations on scientific and operations issues could be expected. Dr. Kreiger pointed out that the telecommunications networks for German research are rapidly growing from the current 34 Mps capacity to an expected 155 Mbps.

Dr. Masahiro Mori, JAERI, described an active program of expansion of telecommunications for remote collaborations. The Naka Establishment, the primary site of JAERI fusion research, has prepared a new Data Link System to allow remote involvement in data analysis and participation on JT-60U; particularly with its partners in the IEA Three Large Tokamak Agreement. Remote analysis of JT-60 data and ISDN based video conferencing with PPPL has been demonstrated, as has the remote operation of neutron diagnostic on JT-60 from LANL. He expressed the hope that a significant expansion of bandwidth for international collaborations could be possible in the near future.

Dr. Tetsuya Sato, National Institute for Fusion Science, noted that a telecommunications link between the U.S. and Japan had been actively used to transfer data for more than a dozen years. All universities and institutes under Monbusho (Ministry of Education, Science, Sports and Culture) are connected through a network called SINET. An upgraded network is planned for plasma and fusion research participants. Dr. Sato noted agreement on promoting remote participation, but since the Large Helical Device was in the final stages of construction, remote participation is likely to have stepwise growth during this transition period.

Dr. Abhijit SEN, India provided a somewhat different point of view, trying to contribute a third world or "non-ITER" perspective on remote collaboration. He noted that many researchers in nations with small fusion or plasma physics activities were isolated, lacking convenient access to the most basic scientific information such as current journals or interactions at conferences. With limited money for high technology experiments and for computational support for theoretical studies, using telecommunications to establish collaborative programs with non-ITER nations can have significant benefits. However, Sen noted to use remote collaboration current telecommunications links would have to be upgraded. An example of current initiative is a network called PLASMANET established by the International Plasma Research Network, a group of several non-ITER nations. Sen observed that a small number of easily accessible centralized databases and a centralized repository of standardized software would encourage data analysis and modeling. He suggested a survey of present non-ITER telecommunication capabilities and minimum technology needs should be completed, with a subsequent request for support from world bodies such as IAEA and UNESCO.

The evening was highlighted by Dr. Glen Wurden, Dr. Kiyotaka Hamamatsu in the hotel meeting room communicating in real time with Dr. Ishitani at JT-60 in Japan. The data from experimental shots were transmitted to Montreal and projected before the audience as Dr. Wurden and Dr. Nishitani simultaneously discussed the images seen on the screen. Periodically Dr. Ishitani speaking from the JT-60 was displayed on the screen to simulate what might happen in a normal collaborative discussion during a remote collaboration. Unfortunately, the meeting day in

Montreal was a holiday in Japan so the control was empty and the data was historical.